

**THE DEVELOPMENT OF THE ODOUR THRESHOLD TEST FOR
ENVIRONMENTAL ODOUR ASSESSMENT**

by

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LIST OF ABBREVIATIONS

ANOVA	Analysis of variance
CCD	Central Composite Design
DOE	Design of Experiment
D/T	Dilution per Threshold
lpm	litre per minute
MRB	Malaysian Rubber Board
ppb	parts per billion
RSM	Response Surface Method
OU	Odour Unit
USMEC	Universiti Sains Malaysia Engineering Campus

UJIAN TAHAP AMBANGAN BAU UNTUK PENILAIAN BAU ALAM SEKITAR

ABSTRAK

Pengeluaran bau boleh menyebabkan gangguan yang serius kepada penduduk di sekitar kawasan tersebut. Di Malaysia, Olfaktometer digunakan untuk mengukur bau berdasarkan nilai kepekatan bau yang dihasilkan. Olfaktometer tersebut amat mahal dan memerlukan operator profesional dalam pengendaliannya. Oleh itu, kajian ini telah dijalankan untuk menghasilkan kaedah pengukuran bau berkonsepkan Beg Bau Tiga Segi. Kaedah pengukuran bau yang dihasilkan di dalam kajian ini mempunyai keunikannya yang tersendiri iaitu roda bau bergambar dan skala keselesaan bau yang digunakan sebagai pengukuran tambahan kepada parameter penilaian bau. Semasa persampelan dan pengukuran bau, sesetengah pembolehubah yang mungkin memberi perubahan kepada nilai kepekatan bau telah dikenalpasti. Pembolehubah tersebut (saiz panel, bilangan beg yang diguna semula dan masa penyimpanan sampel di dalam beg) disaring dengan mengendalikan ujikaji menggunakan rekabentuk factorial. Hasil kajian mendapati hanya bilangan beg yang diguna semula dan masa penyimpanan sampel di dalam beg yang menyebabkan perubahan terhadap nilai kepekatan bau. Di akhir kajian ini, sebuah pokok peramal untuk persampelan dan pengukuran bau dicadangkan untuk analisis pengukuran bau di makmal. Pokok peramal yang dihasilkan di dalam kajian ini berupaya mengenalpasti prosedur penilaian bau dan peralatan yang sesuai untuk digunakan dikawasan pengeluaran bau.

THE DEVELOPMENT OF THE ODOUR THRESHOLD TEST FOR ENVIRONMENTAL ODOUR ASSESSMENT

ABSTRACT

Odour emissions can cause serious annoyance in the neighbourhood of the emission source. In Malaysia, the Olfactometer is used to measure the odour emission which reports odour concentration value. The Olfactometer is very expensive and requires professional odour operator to conduct the equipment. Therefore, this research was conducted to develop an alternative odour measurement method using the Triangular Odour Bag concept. The uniqueness of this study was the design of an illustrated odour wheel and the pleasantness scales as additional odour assessment parameter. During odour sampling and measurement, several variables that might give changes to odour concentration value have been detected. The variables (size of panels, number of reused odour bag and storage time of the sampling bag) were screened in order to check their significance by conducting experiments using factorial design. The results show that out of the three variables, only the number of reused odour bag and storage time of the sampling bag significantly influence odour concentration. At the end of the study, a decision tree for sampling and odour measurement was suggested for laboratory odour measurement analysis. The decision tree developed from this study enables the identification of the suitable odour assessment procedure and equipments to a site's condition.

CHAPTER ONE

INTRODUCTION

1.1 Introduction to odour

Odour is very subjective since different people have different perceptions towards odour. For example, although an odour is categorized as fragrant, if the intensity of the odour is too strong with a long period of time, it would be unpleasant to certain people. Some could accept the emission of odour although it is categorized as malodour. Therefore, the United Kingdom uses the odour wheel as an additional tool to assess odours in its guidelines, as stated by the Department for the Environment, Food and Rural Affairs (2010) to classify the odours into classes according to their characteristics. A lot of odour wheels are available but no specific research on the effectiveness of the odour wheel is available.

The purpose of this study is to introduce and develop an odour measurement method which is adopted from Japan, the Triangular Odour Bag method, as a practical and easy method instead of using the Olfactometer. However, the new developed odour assessment method must be suited to the country's environment and the accessibility of the instruments. The study will focus on sampling and measuring odours since there is no specific method to measure odours. There are some guidelines on sampling and measuring such as the European Standard (13725:2003), the Germany Odour Policy

(Guideline VDI 3882 Part 2) (Frechen, 1997), the Malaysian Standard (MS 1963: 2007) and the Japanese Offensive Law (Iwasaki, 2003).

1.2 Odour pollution and its effect on the surrounding community

Odour exposure could be annoying and be nuisance to human. Unpleasant odour also gives psychological impact and the worst effect is to human health. Repeated exposure to odour can also produce uncomfortable feeling, thus leading to a high level of annoyance. This is also related to complaints, which are most likely to come from individuals that are sensitive to odours.

Prolonged exposure to environmental odour can generate undesirable reactions in humans such as irritation, discomfort, anger, nausea, headache or vomiting (McGinley *et al.*, 2000; Naddeo *et al.*, 2013). This is agreed by Sakawi *et al.* (2013) and they had classified the impact of bad odour into three that is in terms of health, psychology and physiology. From the survey conducted by Sakawi *et al.*(2013) at Desa Jasmin, Nilai, Malaysia, people that perceive odour felt as though their life has been disrupted by the odour (64.1%), affected their freedom (64.1%), affected their health (25%), residents moved away (17.4%) and land use (17.4%).

Sakawi *et al.* (2013) also stated that sensitive odour receivers experienced health problems such as headache, irritation, asthma, flu and the loss of the sense of smell

ability. Odour gives other effects such as an uncomfortable feeling, moodiness, hypertension and decreased job performance for the sensitive receiver. In terms of physiology, malodour tends to make people lose their appetite, experience nausea and high blood pressure, reduced outdoor activities and propose to relocate (Sakawi *et al.*, 2013).

Generally, odour can be categorized into two, which are pleasant and unpleasant. The main concern of this study is about unpleasant odour since it has an impact on the community. In this study, the unpleasant odour is also experienced by the students of Universiti Sains Malaysia Engineering Campus, (USMEC) almost every night and it also can be detected in the daytime if the rain occurs on that day. The source of the odour is suspected to come from industrial activities near the campus. Therefore, an investigation has been carried out and is reported in this study.

1.3 The importance of odour assessment

Odour can contribute to complaints if the emission is too much. Complaints are most likely to come from individuals that are psychologically sensitive to odours. Frechen (1994) concluded that human perception of odour can be illustrated in Figure 1.1.

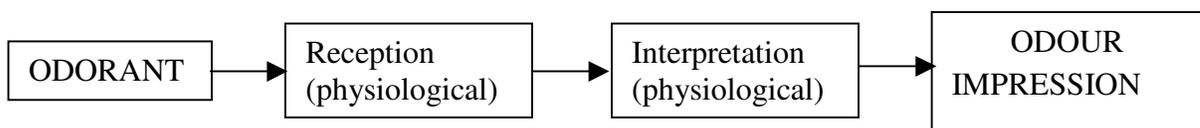


Figure 1.1 Human perceptions towards odour (Source: Schaubberger, 2012)

Unpleasant odours usually give uncomfortable feelings to humans, especially if the exposure is too long. This situation leads to complaints and the local authorities will carry out an inspection on the source of the emission of the unpleasant odour. The emission is then compared to allowable emissions according to the regulations of the country.

Many types of tools are used to measure odour, for example, by using the olfactory, chemicals or machines. However, most countries use the olfactory which uses the human nose to measure the odour since it is a friendly method when compared to other methods. The olfactory techniques can be classified into two, which are static and dynamic. The static method uses manual operations in order to dilute the odorant until it can be first detected by a panel. On the other hand, the dynamic method uses an automatic tool, for example, the Olfactometer to dilute the odorant.

The Olfactometer is a standard odour measurement method in Europe and in many other countries. This tool is used to monitor the dilution of an odorous sample with odourless air for presentation to the panels (AWMA, 2002) and the guidelines are stated in the European standard, EN 13725:2003, Air quality – Determination of odour concentration by Dynamic Olfactometry. It has been used by the Europeans a century ago and the tool has been improved from time to time (van Harreveld, 2003). A method called the Triangular Odour Bag method was developed by the Japanese over 40 years ago. This

method is manually set by humans using an odour bag and a syringe (Iwasaki, 2003). Currently in Malaysia, the Olfactometer is used to measure odour. Detail of the odour measurement methods that available are discussed in chapter two.

1.4 Problem statement

The existing odour measurement methods, for example, the Olfactometer, Triangular Odour Bag and the Nasal Ranger report the odour in odour concentration value. The odour concentration value does not describe the characteristics of an odour, but only represent the level of odour threshold that can be detected by a set of panel. In other words, a high odour concentration value does not necessarily indicate a malodour rather the high concentration indicates a very strong smell, which could be either nice smelling or stinky. Thus, a third odour parameter is needed to better represent the odour assessment, which could be by means of an odour wheel. As reviewed in chapter two, odour wheel has been used in several odour assessments, but the highly descriptive nature of the odour characters although helped in odour identification, is difficult to implement on odour assessors if no prior training was conducted. A graphical odour wheel where illustrations are used instead to classify and describe odour character may be more user friendly and effective, however, no such study has been reported so far.

The olfactometry assessments have been shown to be influenced by odour bags with regards to the triangle odour bag method, there is missing information about the effect of the reused odour bag on reported odour values. A study looking at the combined effect of